Relationships Between Losses and Vehicle Density 1982-84 Models

Highway Loss Data Institute

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Insurance Special Report

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HLDI A-25

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Highway Loss Data Institute — Watergate Six Hundred — Washington, D.C. 20037
Research Report HLDI A-25; October 1985
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SUMMARY

This Highway Loss Data Institute (HLDI) study illustrates the influence of vehicle density (measured as number of registered cars per square mile) on insurance collision losses and on first-party medical losses in no-fault states. This report summarizes the frequency and severity of collision and injury claims for five categories of increasing vehicle density. Results, based on the collision experience of 1982 models and the injury experience of 1982-84 models, are presented for passenger cars (small, midsize, and large), vans, small and standard pickups, and small and intermediate utility vehicles.

Personal Injury Protection Coverages

- The frequency of all injury claims and the frequency of claims with medical losses of more than $1,000 increased as vehicle density increased from low to high for each of the three passenger car size groups (Figure 1, page 5; Figure 4, page 8).
- The patterns of injury losses by vehicle density were not consistent for pickups, vans, and utility vehicles. The frequency of all injury claims increased with increasing vehicle density for small pickups; they exhibited no pronounced relationships for standard pickups, vans, and intermediate vehicles; and for small utility vehicles, they decreased with increasing density (Figure 2, page 6).

Collision Coverages

- As vehicle density increased from low to high, collision claim frequencies for passenger cars increased for each car size group (Figure 7, page 11).
- Among vans, pickups, and utility vehicles, collision coverage claim frequencies increased with increasing vehicle density, except for small utility vehicles, which had a relatively higher claim frequency in the lowest density category (Figure 8, page 12).
- In general, the average loss payment per claim remained constant as vehicle density increased. The exception was small utility vehicles, which had decreasing average loss payments per claim with increasing vehicle density. Vans had consistently lower average loss payments per claim within each of the vehicle density categories (Figure 10, page 14; Figure 11, page 15).
- The average loss payment per insured vehicle year remained relatively constant for all vehicle densities for vans, small and standard pickups, and intermediate utility vehicles; it increased with increasing vehicle density for passenger cars; and it decreased with increasing vehicle density for small utility vehicles (Figure 13, page 17; Figure 14, page 18).

INTRODUCTION

The Highway Loss Data Institute (HLDI) is a nonprofit, public service organization that gathers, processes, and publishes insurance data concerning the human and economic losses associated with motor vehicles — especially the ways such losses vary among different kinds of vehicles.

Previous HLDI reports (A-2 and A-4) on the relationship of collision coverage losses to vehicle density (the number of registered cars per square mile) concluded that vehicles garaged in high density areas generally produced more frequent collision claims, but with lower average loss payments per claim, than vehicles garaged in low density areas. Those studies also concluded that the influence of vehicle density on the frequency and size of collision claims was consistent for each of the four car size classes (subcompact, compact, intermediate, and full size) considered at that time.

This report examines the effect of vehicle density on the collision experience of 1982 models and the injury experience of 1982-84 models. Results are presented for passenger cars (small, midsize, and large), vans, small and standard pickups, and small and intermediate utility vehicles.

The results in this report are based on personal injury protection and collision coverage loss data supplied by nine insurers: Aetna, Allstate, Fireman's Fund, GEICO, Liberty Mutual, Prudential, Sentry, State Farm, and Travelers.

METHOD OF DATA ANALYSIS

Vehicle density, measured as the number of registered passenger cars per square mile, was determined for every county and independent city in the United States.[1] Five categories of increasing vehicle density were defined for use in this report with approximately 20 percent of the total number of registered passenger cars in each category. Each vehicle in the HLDI data base was assigned to one of the five groups by matching the zip code of the vehicle's garaging location with its appropriate county or independent city. The density categories and examples of counties from each category are given in Table 1.

TABLE 1
Definitions and Examples of Vehicle Density Categories

Density Category	Cars Per Square Mile		Example County
	> Lower Limit	≤ Upper Limit	
1 (Low)	0	41	Billings County, ND Huntington County, PA
2	41	144	Nantucket County, MA Schuylkill County, PA
3	144	429	New London County, CT Schenectady County, NY
4	429	984	Providence County, RI Sacramento County, CA
5 (High)	984	—	Los Angeles County, CA Queens County, NY

[1] An independent city is defined as a city that is not contained within a county. The registered passenger car information, based on the 1980 Census data, and land area information, were obtained from Rand McNally-Infomap, Inc., Chicago, Illinois.

RESULTS AND DISCUSSION

Personal Injury Protection Coverage Results

The frequency of all injury claims increased as vehicle density increased from low to high. As shown in Figure 1 (page 5), the increases in overall injury claim frequency as vehicle density increased were consistent for each passenger car size group.[2] For all injury claims for pickups, vans, and utility vehicles, the patterns of injury losses by vehicle density were not consistent (Figure 2, page 6). Injury claim frequencies for small pickups were similar to those for passenger cars; they showed no pattern of relationship to vehicle density for standard pickups, vans, and intermediate utility vehicles; and they decreased for small utility vehicles with increasing density. Two-door, four-door, station wagon, and sports and specialty passenger cars had similarly increasing overall injury claim frequencies as vehicle density increased (Figure 3, page 7). The two-door cars showed consistently higher claim frequencies across all of the density categories.

Figures 4 through 6 (pages 8-10) present claim frequencies for severe injury (claims in which the medical payments exceeded $1,000).[3] In general, severe injury claim frequencies increased as vehicle density increased. For all three sizes of passenger cars, the patterns of severe injury claim frequencies were consistent; within each density category, the smaller the car, the higher the frequency of severe injury (Figure 4). The pattern of results was similar for small pickups and passenger cars (Figure 5). Vans and standard pickups showed similar trends in the frequency of severe injuries across the density categories. Four-door passenger cars, station wagons and sports and specialty models had similar frequencies of severe injury in the two lowest density categories (Figure 6). However, as vehicle density increased in the three highest categories, station wagons had consistently lower injury claim frequencies. Two-door passenger cars had the highest frequencies of severe injury within each of the density categories.

Collision Coverage Results

Figures 7 through 9 (pages 11-13) present collision coverage claim frequencies for the five vehicle density categories for all passenger cars, vans, small and intermediate utility vehicles, and small and standard pickups.[4] In general, the collision claim frequencies increased as vehicle density increased. Figure 7 shows increasing collision claim frequencies, regardless of car size, as vehicle density increases. For each vehicle density category, claim frequencies were highest for small cars and decreased with car size. Collision claim frequencies increased with vehicle density for all cars and small pickups (Figure 8). They also increased for vans, standard pickups, and small and intermediate utility vehicles, but the increases were not pronounced. Small utility vehicles had an unusually high frequency of collision claims in the lowest density category compared to the claim frequency for this group of vehicles in the second lowest density category. Claim frequencies for each of the passenger car body styles increased with vehicle density (Figure 9).

As shown in Figure 10 (page 14), no relationship between average loss payment per claim and vehicle density was found for passenger car size. For small utility vehicles, average loss payment per claim decreased with increasing vehicle density (Figure 11, page 15). In addition, this decrease was the largest change among the six vehicle types in relation to density. Average loss payment per claim for vans was the lowest among the six vehicle types. Results for vans were constant for the two lowest and two highest density categories but decreased in the middle category. There was no relationship between average loss payment per claim and vehicle density for all cars, small and standard pickups, and intermediate utility vehicles. None of the passenger car results for average loss payment per claim showed a relationship with vehicle density and body style (Figure 12, page 16). Results for the sports and specialty vehicles were consistently higher than the two-door, four-door, and station wagon results within each density category.

Figures 13 through 15 (pages 17-19) present average loss payment per insured year of exposure. The average loss payment per insured vehicle year increased as vehicle density increased for all car size groups (Figure 13). Within each density category, average loss payments per insured vehicle year were greatest for small cars, followed by midsize and large cars, respectively. In Figure 14, average loss payments per insured vehicle year for all passenger cars increased with vehicle density. For vans, the average loss payment per insured vehicle year was consistently lower within each of the five density groups. Small utility vehicle results decreased with increasing vehicle density. The results for the other vehicle types showed no relationship with vehicle density.

For small utility vehicles, injury claim frequencies (Figure 2), collision claim frequencies (Figure 8), average loss payment per claim (Figure 11), and average loss payment per

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[2] Injury results were standardized to eliminate effects due to operator age groups. See Appendix A for standardizing weights.

[3] Utility vehicles were not reported because the required 25,000 years of exposure necessary for reporting severe injury results were not available.

[4] Collision results were standardized to eliminate effects due to operator age groups and deductible amounts. See Appendix A for standardizing weights.

insured vehicle year (Figure 14) tend to be high in the lowest density category. These higher results in the low density categories may be the result of increased off-road use for many of these vehicles.

Sports and specialty models had substantially higher average loss payments per insured vehicle year within each density category compared to the other three body styles (Figure 15). Average loss payments per insured vehicle year increased for regular two-door, four-door, and sports and specialty models with increasing vehicle density for the three highest density groups. Station wagons had higher average loss payments per insured vehicle year in the second highest density category than in any of the other categories. The results for all four body styles showed no relationship with vehicle density for the three lowest density categories.

Because collision and injury coverage results are given by body style, as well as vehicle size, Table 2 gives the percentage of HLDI's 1982 collision exposure for the five density categories for each vehicle type. As expected, a large proportion (45-60 percent) of the exposure for pickups and utility vehicles is in the two lowest density categories. Similarly, passenger cars and vans have a substantial proportion (42-51 percent) of their exposure in the two highest density groups.

Table 3 shows the percentage distribution of collision coverage exposure by density category and vehicle size class for 1982 passenger cars. Across the three size classes, approximately 70 percent of the exposure was found in the three higher density categories. In addition, the three size classes had similar exposure distibutions over the density categories.

TABLE 2
Percentage Distribution of Collision Coverage Exposure By Density Category and Vehicle Type for 1982 Models

Vehicle Type	Density Category				
	1 (Low)	2	3	4	5 (High)
Two-door Passenger Car	13	18	21	23	25
Four-door Passenger Car	16	19	21	21	23
Station Wagon	16	20	22	21	21
Sports & Specialty	12	17	20	25	26
Vans	16	20	21	22	21
Small Pickups	24	25	21	17	13
Standard Pickups	35	25	17	15	8
Small Utility Vehicles	22	23	21	18	16
Intermediate Utility Vehicles	27	21	19	19	14

TABLE 3
Percentage Distribution of Collision Coverage Exposure By Density Category and Vehicle Size Class for 1982 Passenger Cars

Vehicle Size Class	Density Category				
	1 (Low)	2	3	4	5 (High)
Small	12	18	22	23	25
Midsize	14	19	21	23	23
Large	18	18	19	22	23

Figure 1
Personal Injury Protection Coverage
Overall Injury Claim Frequencies
1982-84 Passenger Cars by Size

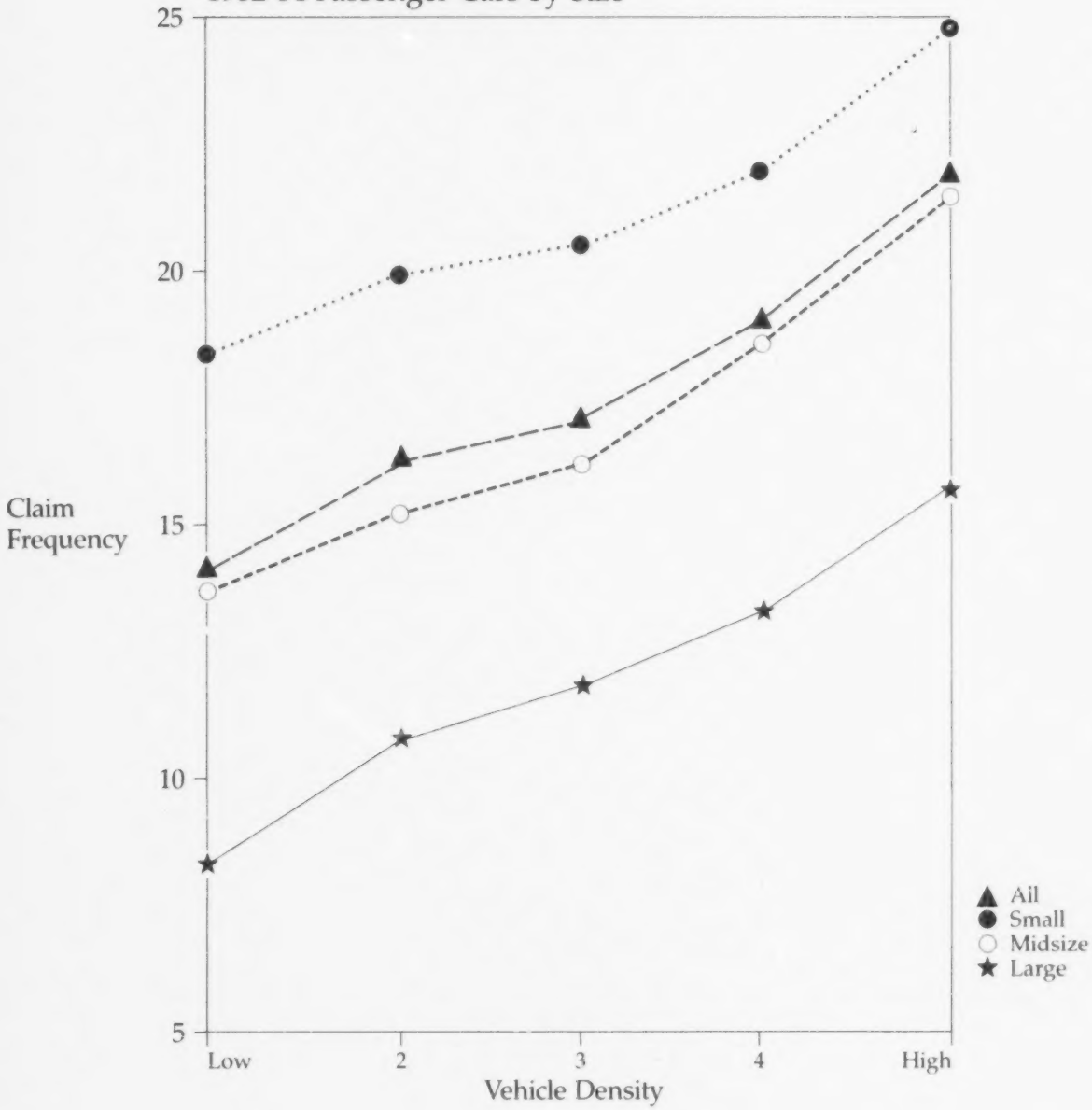


Figure 2
Personal Injury Protection Coverage
Overall Injury Claim Frequencies
1982-84 Vans, Pickups, and Utility Vehicles

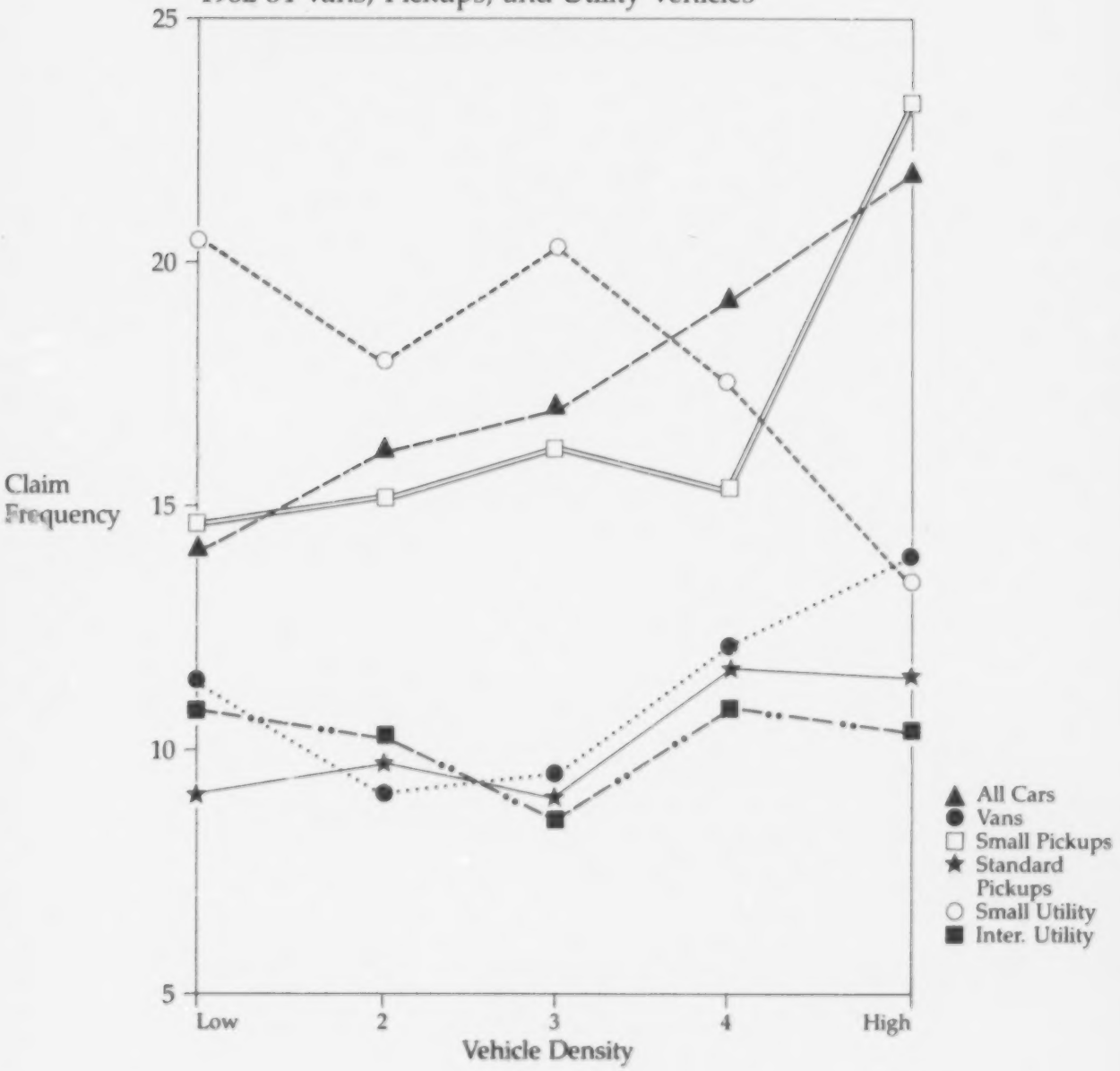


Figure 3
Personal Injury Protection Coverage
Overall Injury Claim Frequencies
1982-84 Passenger Cars by Body Style

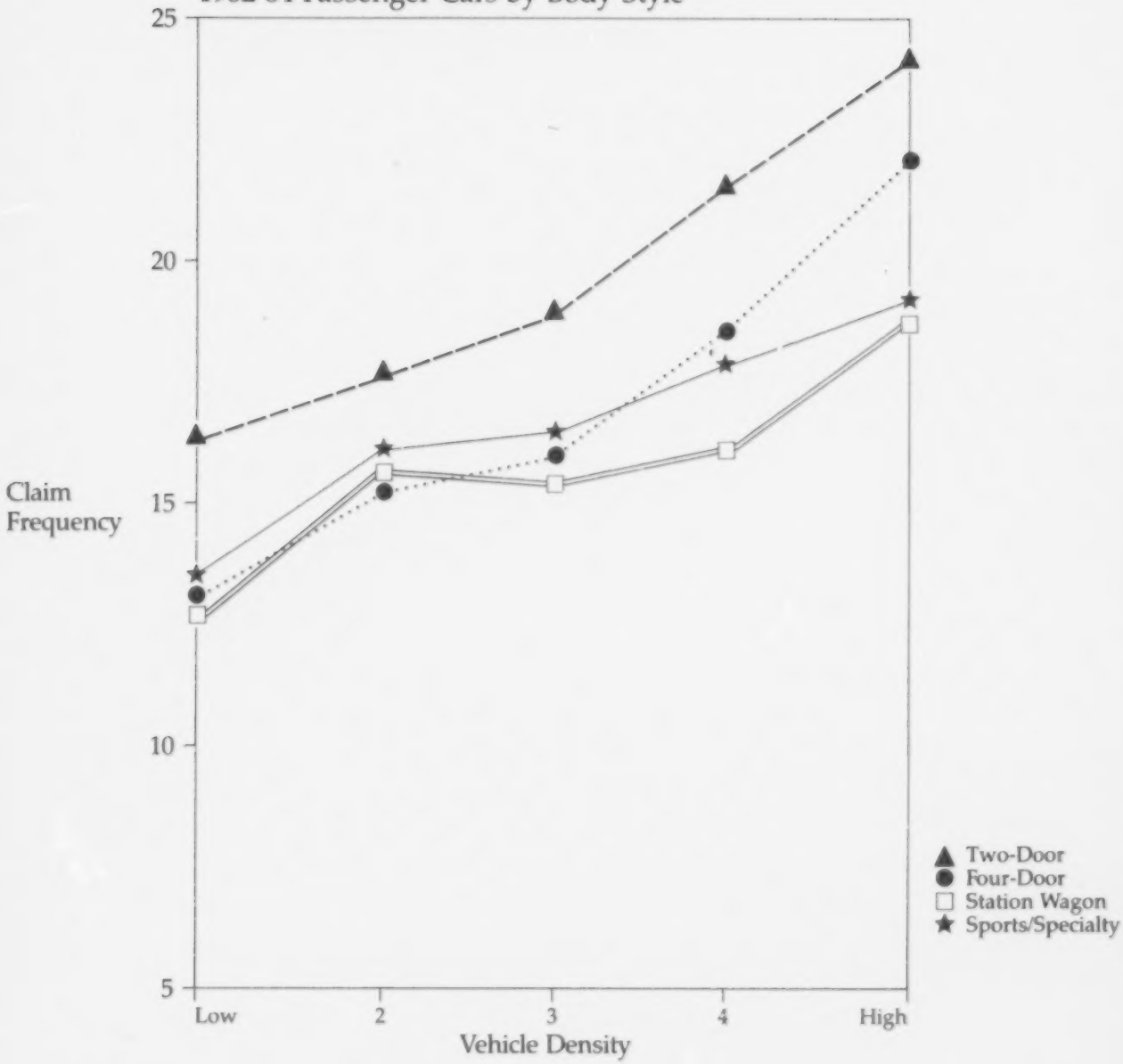


Figure 4
Personal Injury Protection Coverage
Claim Frequencies for Severe Injury (> $1000)
1982-84 Passenger Cars by Size

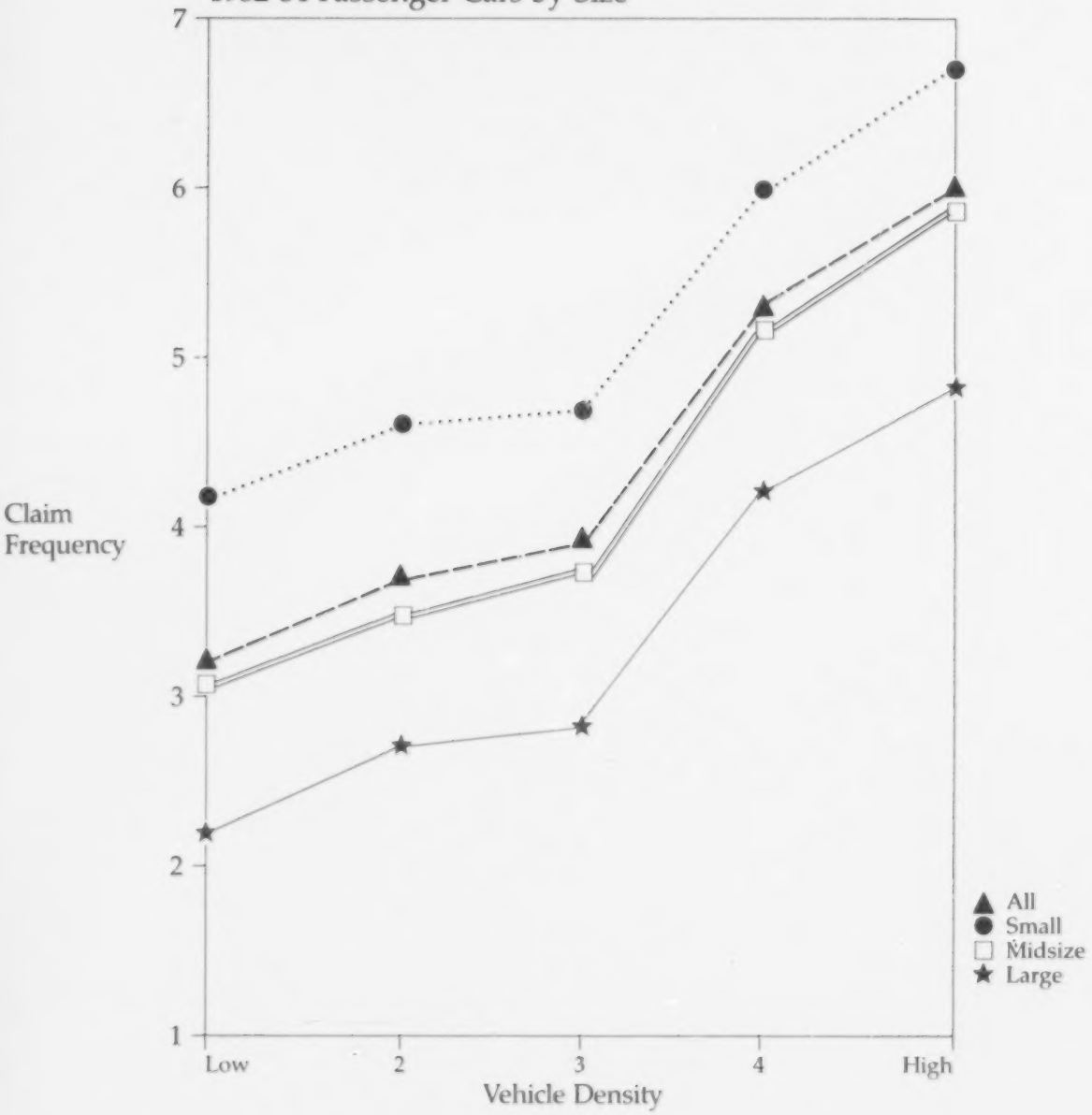


Figure 5
Personal Injury Protection Coverage
Claim Frequencies for Severe Injury (> $1000)
1982-84 Vans and Pickups

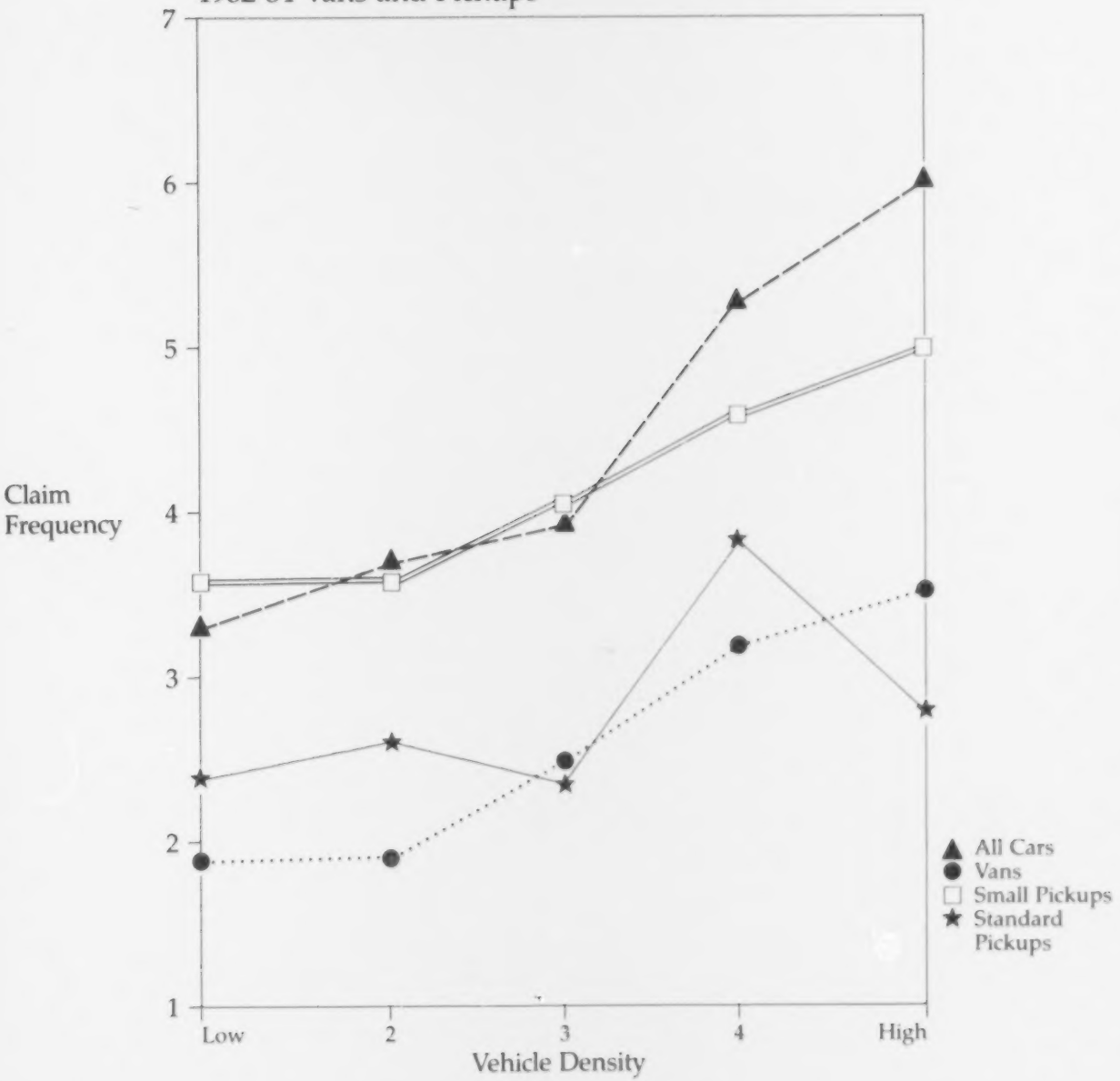


Figure 6
Personal Injury Protection Coverage
Claim Frequencies for Severe Injury (> $1000)
1982-84 Passenger Cars by Body Style

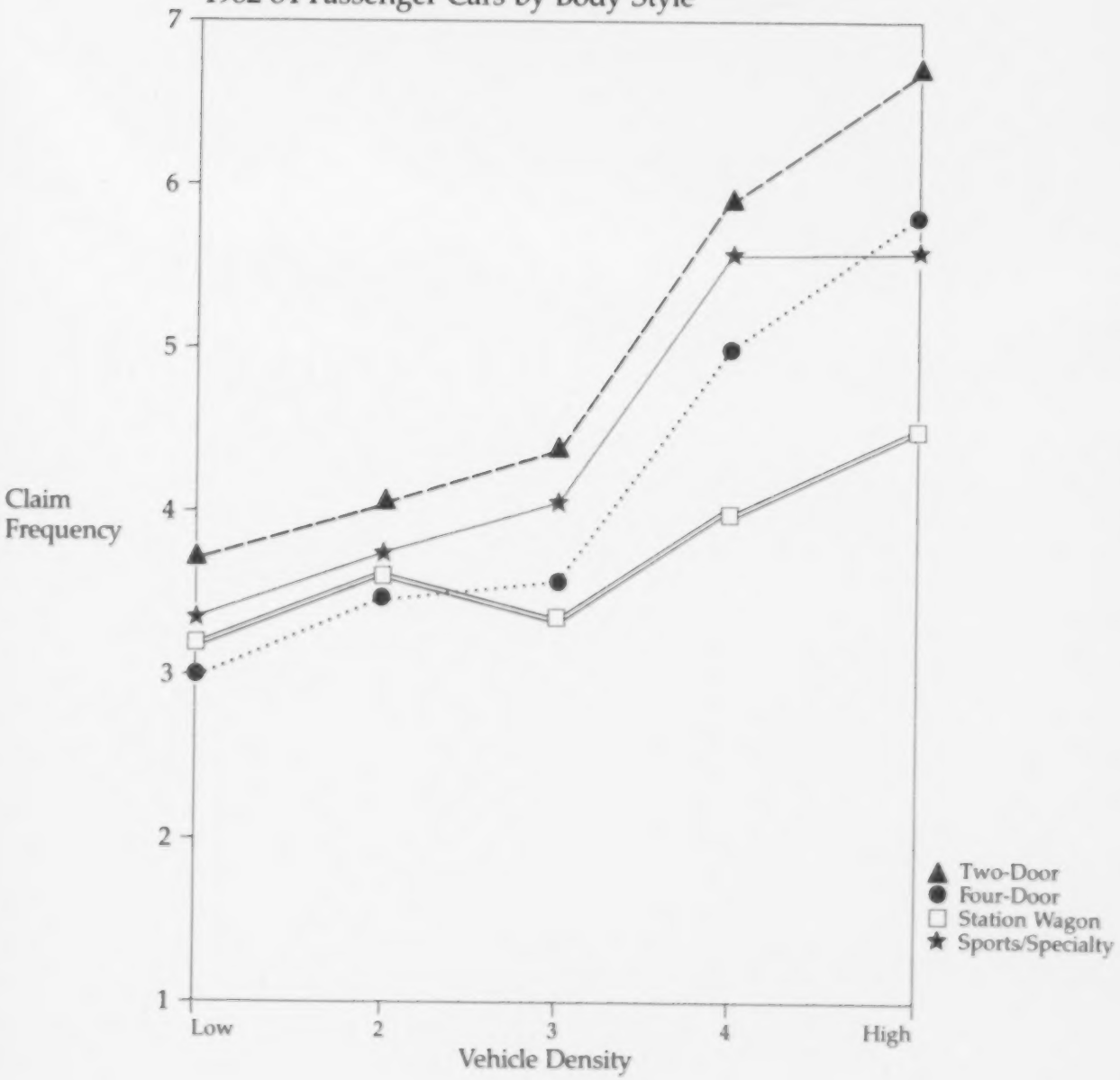


Figure 7
Collision Coverage Claim Frequencies
1982 Passenger Cars by Size

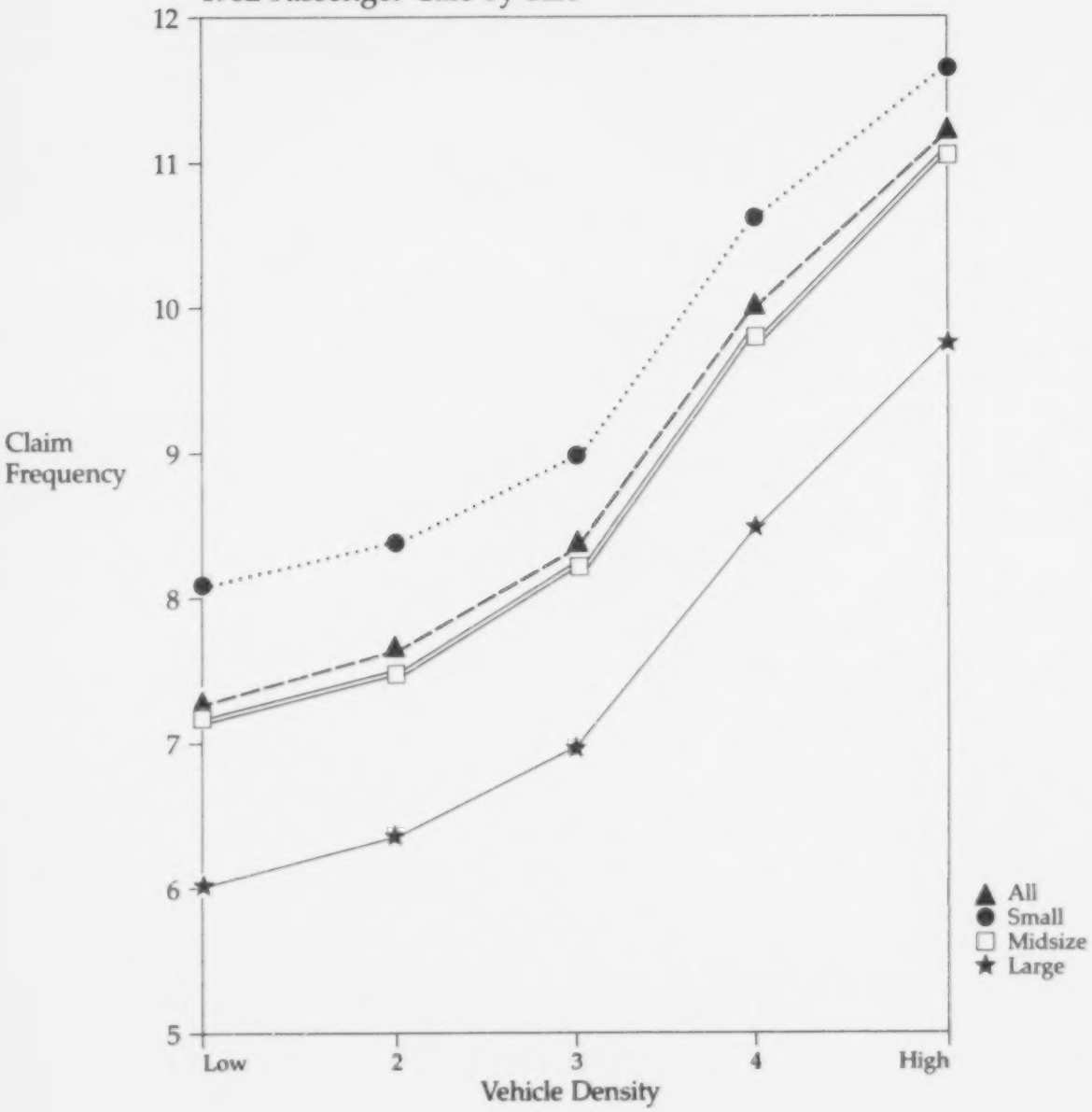


Figure 8
Collision Coverage Claim Frequencies
1982 Vans, Pickups, and Utility Vehicles

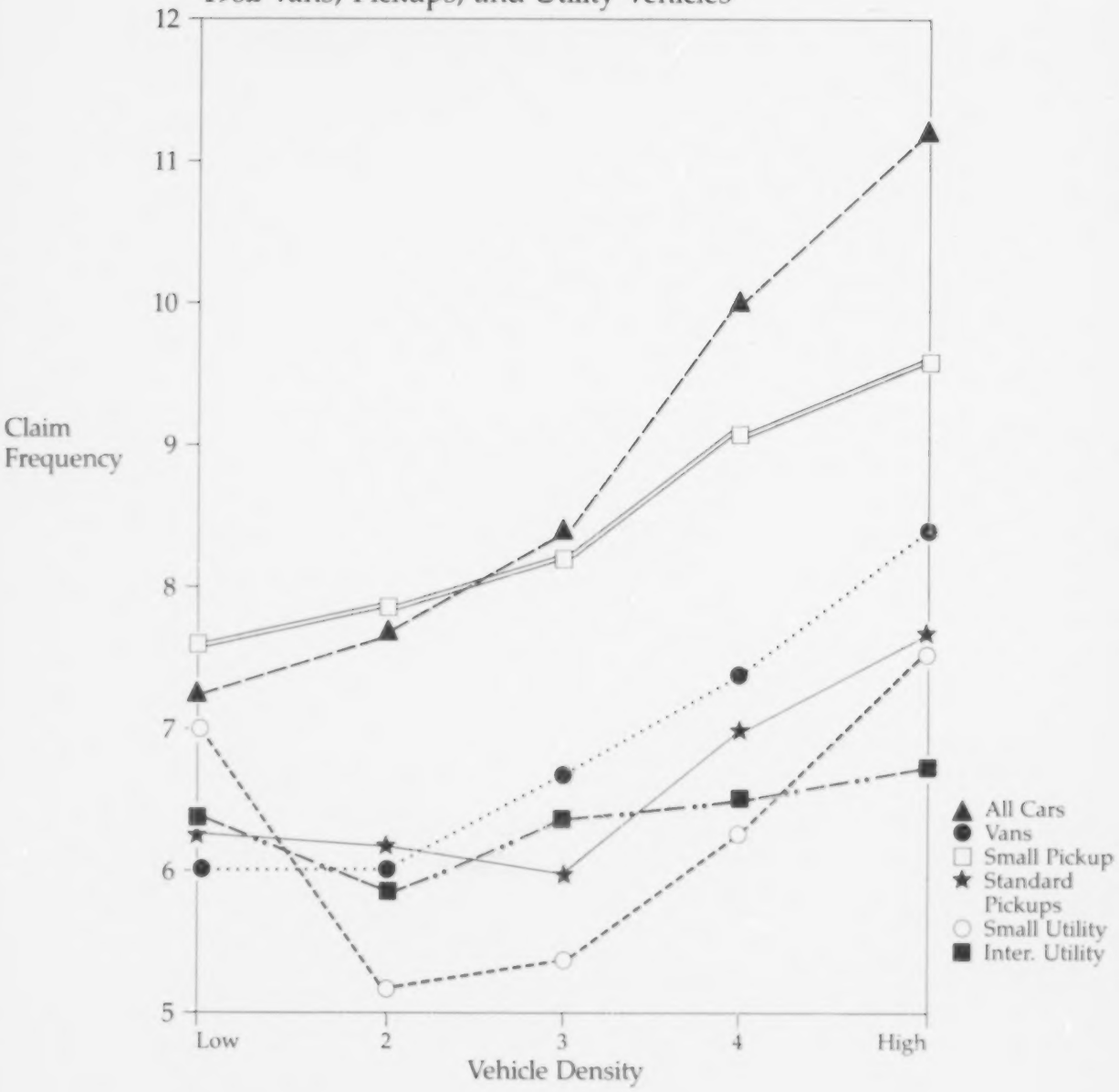


Figure 9
Collision Coverage Claim Frequencies
1982 Passenger Cars by Body Style

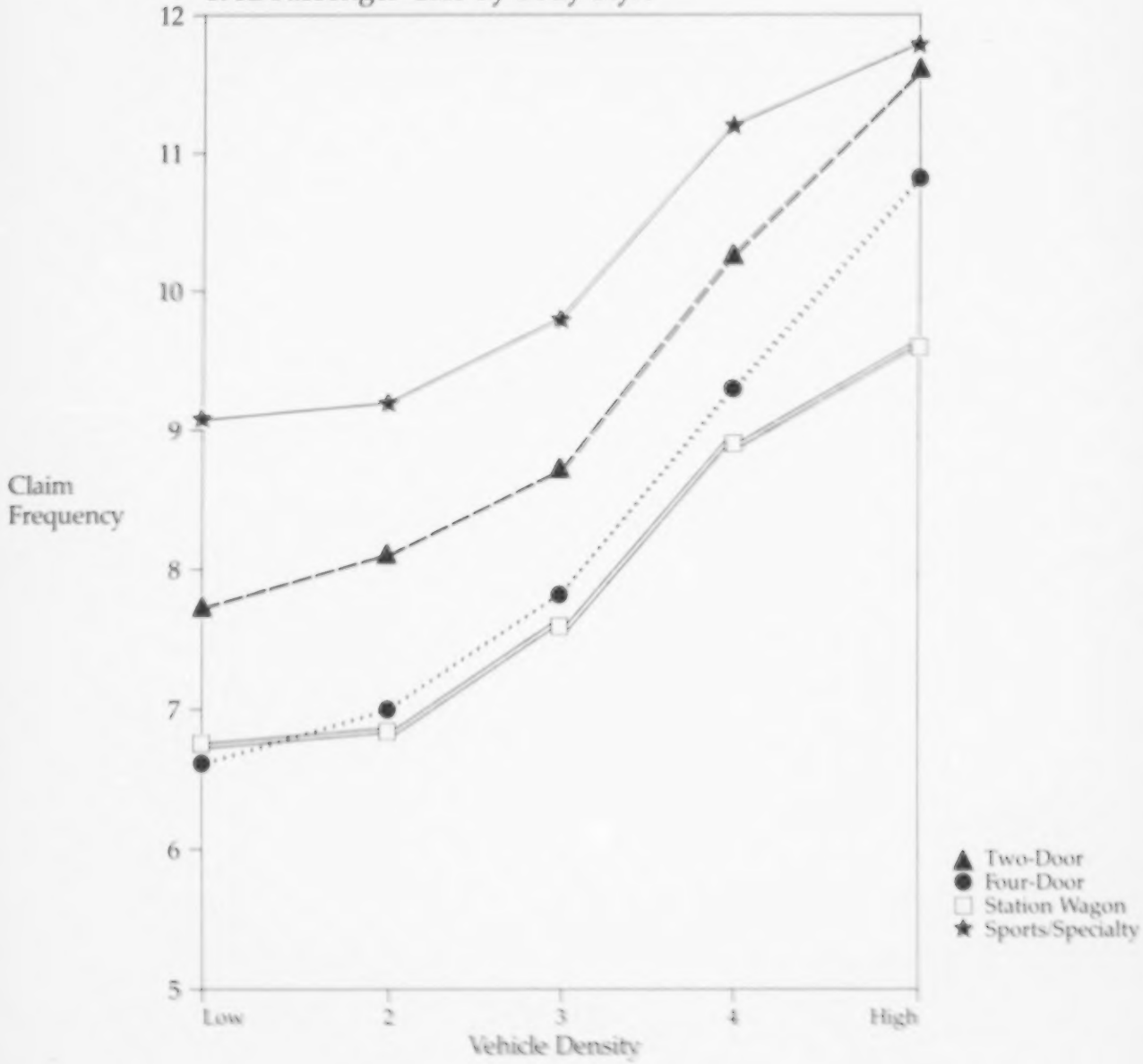


Figure 10
Collision Coverage
Average Loss Payment Per Claim
1982 Passenger Cars by Size

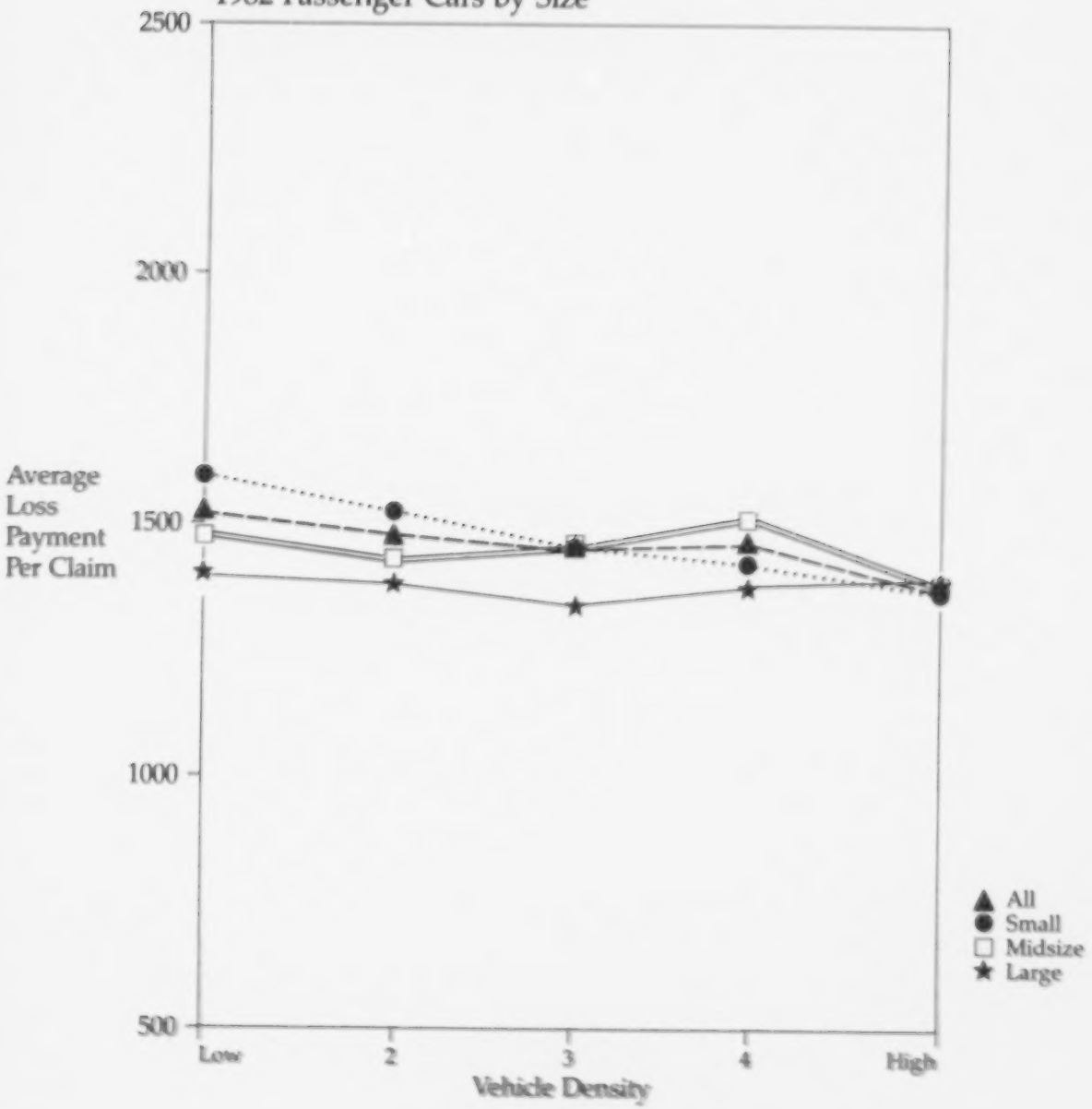


Figure 11
Collision Coverage
Average Loss Payment Per Claim
1982 Vans, Pickups, and Utility Vehicles

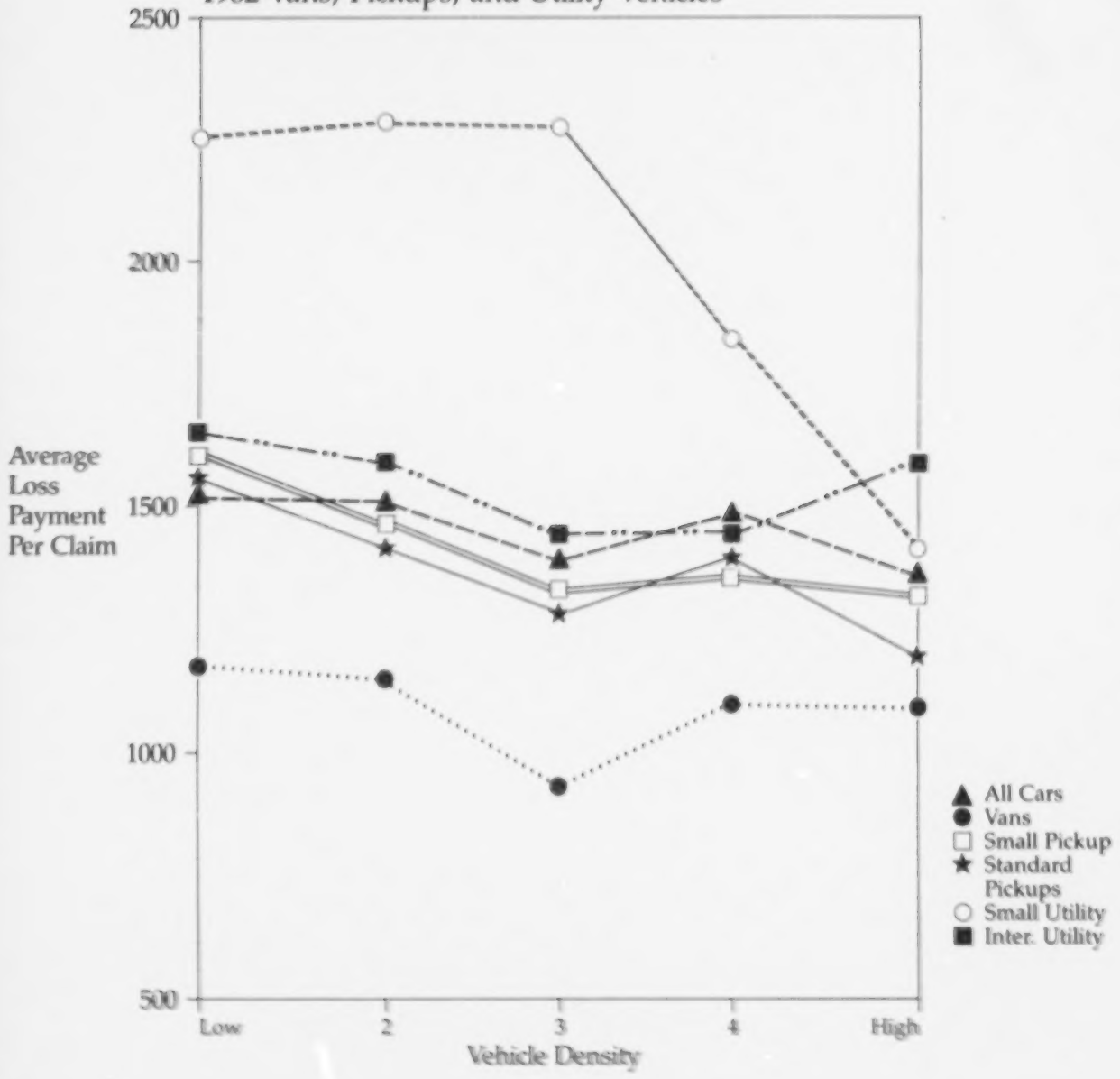


Figure 12
Collision Coverage
Average Loss Payment Per Claim
1982 Passenger Cars by Body Style

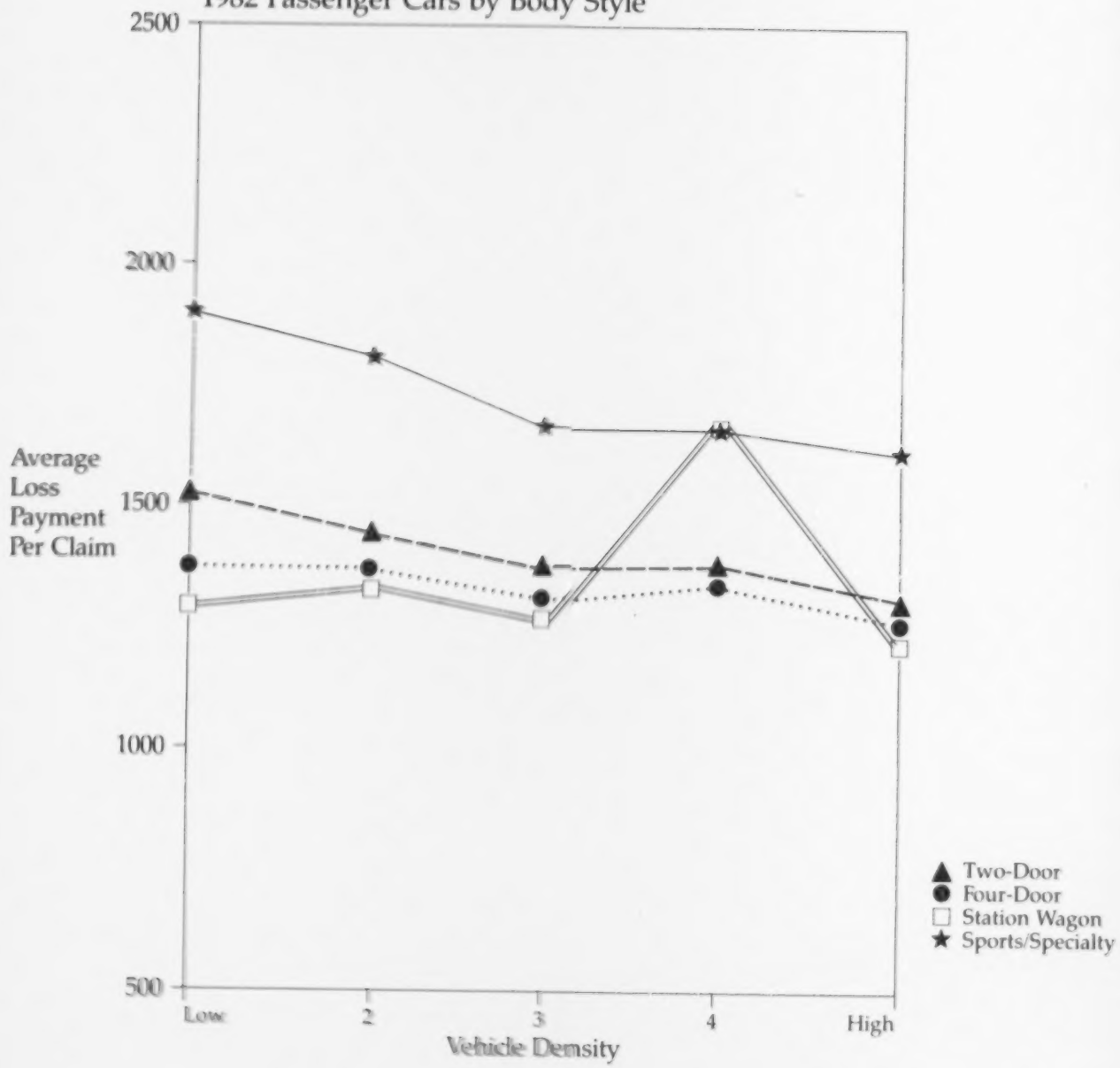


Figure 13
Collision Coverage
Average Loss Payment Per Insured Vehicle Year
1982 Passenger Cars by Size

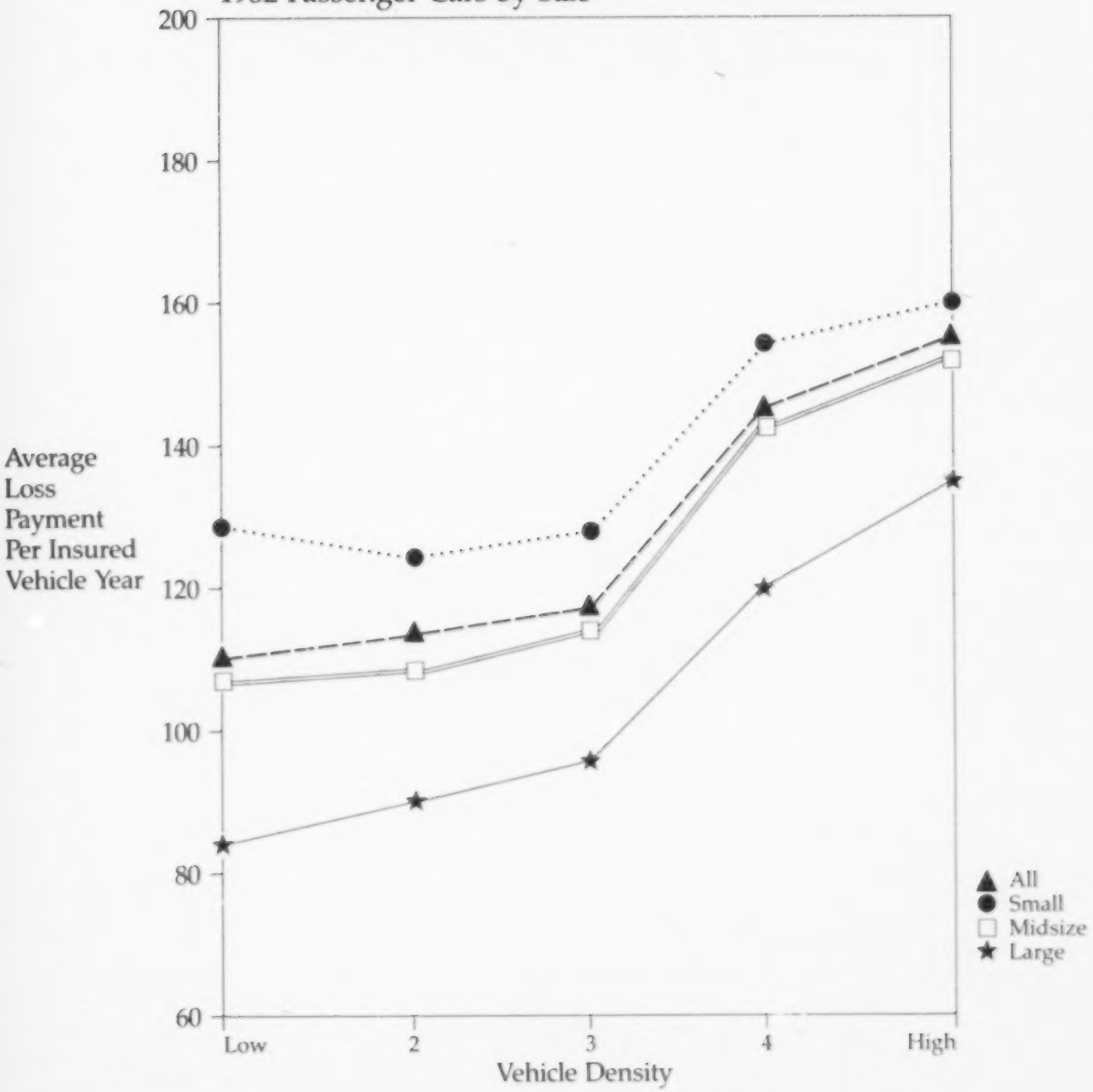


Figure 14
Collision Coverage
Average Loss Payment Per Insured Vehicle Year
1982 Vans, Pickups, and Utility Vehicles

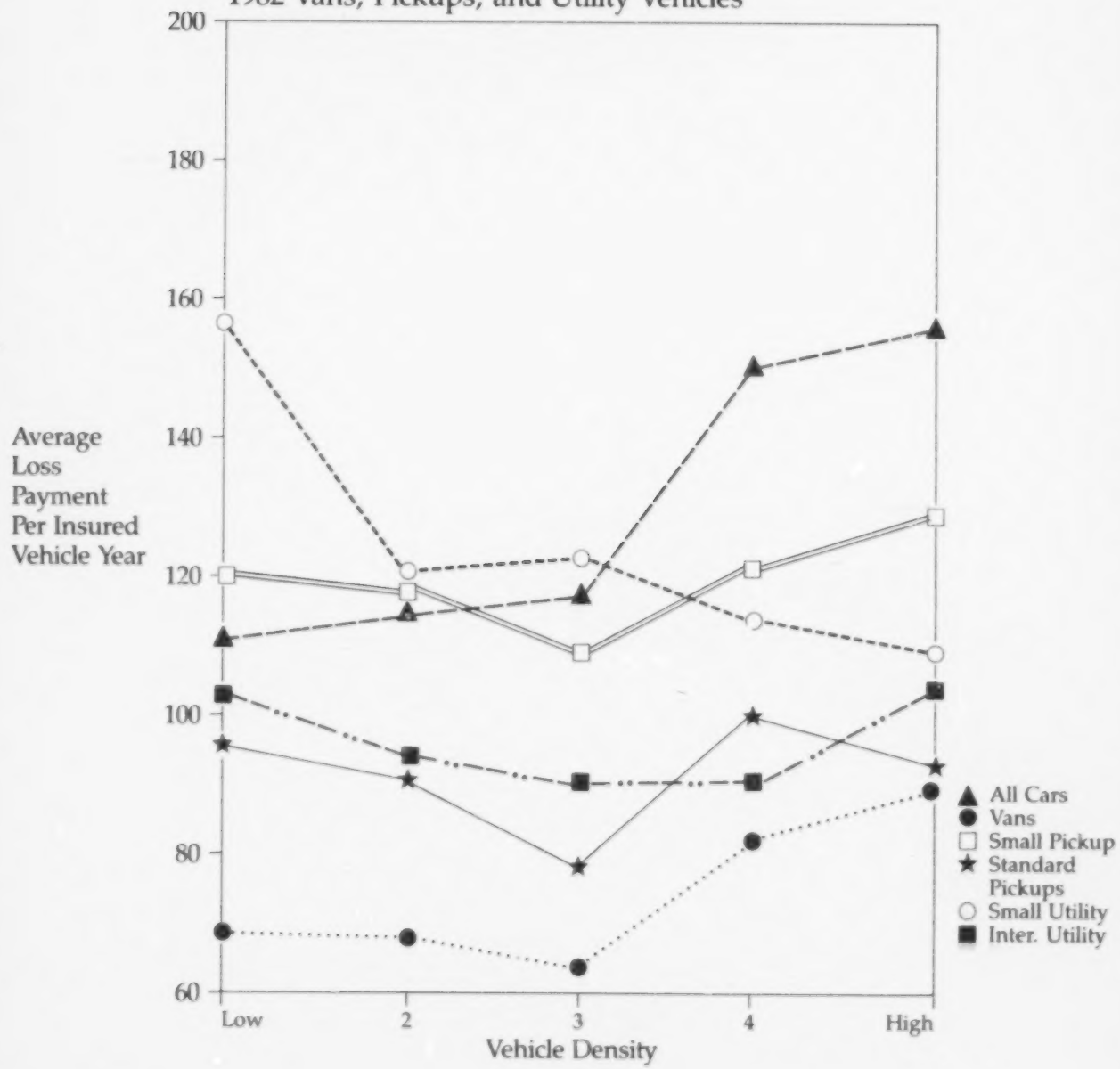
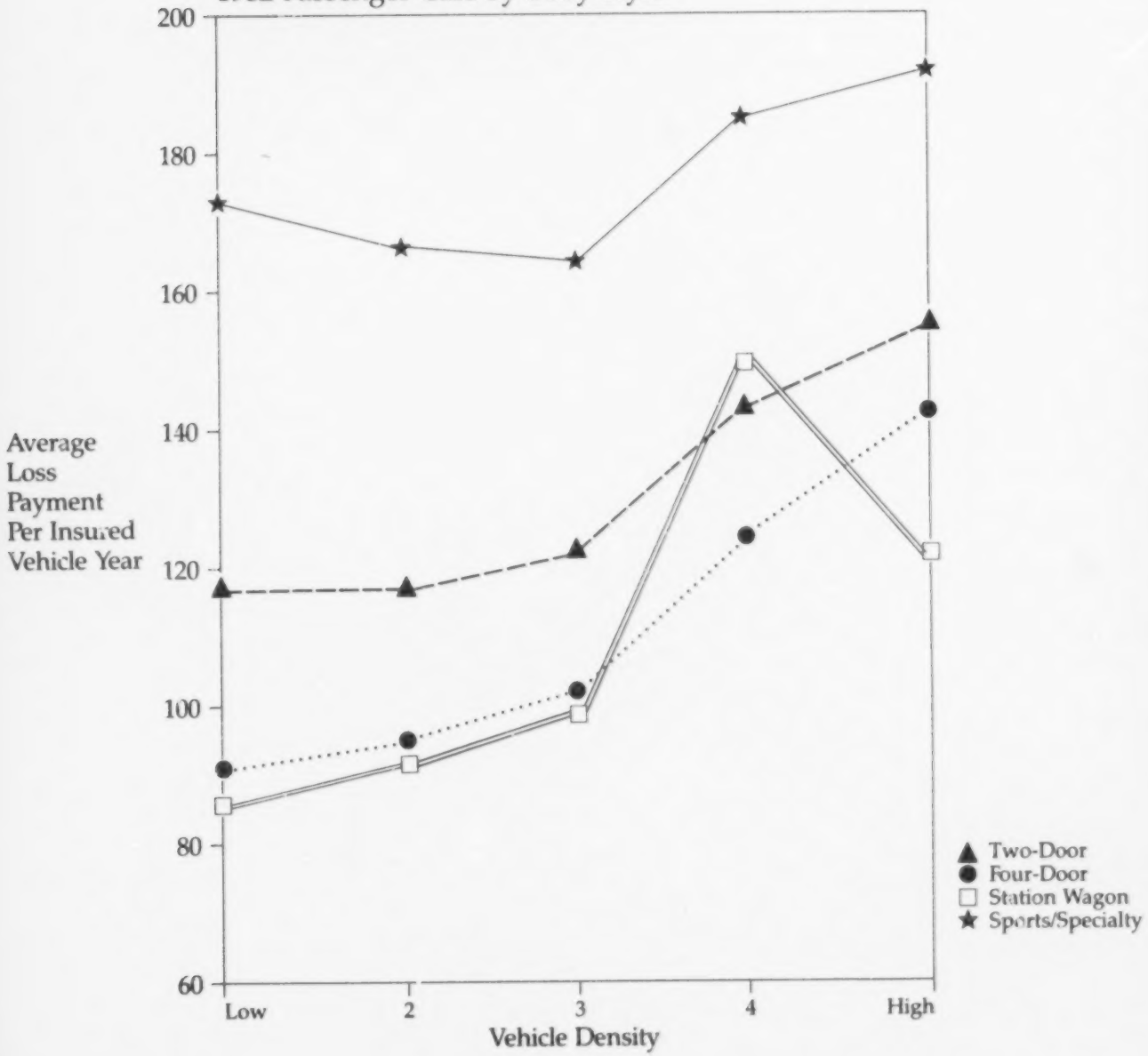


Figure 15
Collision Coverage
Average Loss Payment Per Insured Vehicle Year
1982 Passenger Cars by Body Style



APPENDIX A Standardization

Insurance loss experience varies in relation to certain nonvehicle factors. With respect to Personal Injury Protection (PIP) coverages, one important factor that influences loss experience is operator age. Youthful operators generally have worse loss experience than older drivers. Thus, the proportions of youthful operators must be taken into consideration in comparing the loss experience of different vehicles.

To remove any biases that could result because of variations among different vehicles in an operator age group, the PIP coverage results for the vehicles in this study were weighted, or standardized, to produce a weighted average of actual results. The weights used in the standardization procedure are shown below.

Operator Age Group	Distribution
Youthful	.10
Nonyouthful	.90

With respect to collision coverages, both the frequency and average size of collision losses vary with the deductible amount and the age group of the operators. Therefore, collision coverage results for the vehicles in this study were standardized using the weights shown below.

Deductible	Youthful Operator	Nonyouthful Operator
< $150	.05	.50
≥ $150	.05	.40

Standardizing these nonvehicle factors ensures that their mix is the same for each result. Therefore, to the extent that age distributions within each operator age group and amounts within each deductible group do not vary substantially for different vehicles, these effects will not bias comparisions among the various results.

The standarization procedure employed is widely used in health statistics.* The basic principle of the method is the introduction of a selected population with a standard distribution across operator age group, or across the combination of operator age group and deductible, as represented by the standardization weights in the tables.

APPENDIX B Definitions

Average Loss Payment per Claim — The total of all loss payments made for the claims for a group of vehicles, divided by the number of claims paid; expressed as dollars per claim.

Average Loss Payment per Insured Vehicle Year — For a group of vehicles, the product of Claim Frequency and Average Loss Payment per Claim, divided by 100; expressed as dollars per insured vehicle year. It should be noted that this definition differs from the commonly used insurance term, pure premium, but yields similar results.

Collision Claim Frequency — The number of claims for a group of vehicles, divided by the exposure for that group; expressed as claims per one hundred insured vehicle years.

Collision Coverages — As defined in insurance contracts, the coverage under which people insure their own vehicle against loss caused by collision.

Deductible Amount — That portion of the collision damage cost borne by the policyholder. For computing results, deductible amounts are split into two groups; less than $150 (mainly $50 and $100 deductibles) and greater than or equal to $150 (mainly $200 and $250 deductibles).

Exposure — The time interval an individual vehicle is insured. Exposure for a group of vehicles is expressed in units of insured vehicle years.

Personal Injury Protection (PIP) Claim Frequency — The number of claims for a group of vehicles, divided by the exposure for that group; expressed as claims per one thousand insured vehicle years.

Personal Injury Protection Coverage — First-party no-fault coverage in which an insurer pays, within the specified limits, the medical, hospital, and other expenses of the insured, others in his vehicle, and pedestrians struck by him.

Operator Age Group — The factor that distinguishes those vehicles whose rated driver is youthful from those vehicles whose rated driver is not youthful (see Youthful Operator).

Rated Driver — The driver who, for insurance purposes, is considered to represent the greatest loss potential for the insured vehicle.

Vehicle Class — The four vehicle classes are defined as follows:

1. Passenger Vehicles — There are four major body style groupings of passenger vehicles — regular two-door models, regular four-door models, station wagons and passenger vans, and sports and specialty models. Sports and specialty models include all two-seater cars, all convertibles, all midsize and large cars with two or fewer designated rear seating positions, and all luxury cars. Each body style group is further divided into size class subgroups based on wheelbase (rounded to nearest inch) defined as follows:

*For example, see Armitage, P. *Statistical Methods in Medical Research*, Wiley, New York (1971).

Small — Vehicles with wheelbases less than or equal to 99 inches.

Midsize — Vehicles with wheelbases greater than 99 inches and less than or equal to 109 inches.

Large — Vehicles with wheelbases greater than 109 inches.

2. Vans — Fully enclosed vehicles with either no hood or a very short hood, in which the engine is placed at least 50 percent behind the windshield. The driver's position is usually well forward, nearly beside the engine, usually within the forward 25 percent of the wheelbase. These vehicles are designed for cargo transport and are equipped with a right side cargo access door and rear door. The cargo area is not separated from the passenger area — both are enclosed under the same roof. Some passenger vans are equipped with additional seats in the cargo area and usually have additional side windows also.

3. Pickups — Cargo-carrying vehicles, usually on a truck chassis, with an enclosed cab and a separate open cargo area. The open cargo area generally is a box with raised sides with an opening tailgate. There are also a small number of auto pickups that are similar to regular pickups except that they are built on a passenger car chassis. Pickups are further divided into two subgroups based on curb weight — small pickups (less than 3,000 pounds) and standard pickups (3,000 pounds or more).

4. Utility Vehicles — Vehicles built on a heavy-duty chassis capable of off-road use. They are of conventional construction with the driver behind the engine. The cargo and passenger areas are integral with the driver area. Many of these vehicles are equipped with soft or removable tops. Frequently, these vehicles are equipped with four-wheel drive. Utility vehicles are further divided into three subgroups based on wheelbase — small utility vehicles (less than 100 inches), intermediate utility vehicles (from 100 to 120 inches), and large utility vehicles (greater than 120 inches).

Vehicle Identification Number (VIN) — A code, variously comprising both numbers and letters; normally, 8 to 17 characters in length, assigned to each vehicle by its manufacturer. The VIN uniquely identifies the vehicle within at least a ten-year span and, in recent model year vehicles, contains coding which identifies the make, series, model year, and other characteristics of each vehicle.

Vehicle Series — A name denoting a family of vehicles, within a make, with the same wheelbase and a degree of commonality in construction such as body, chassis, etc.

Youthful Operator — For the purposes of this report, all males (married or single) under 25 years of age and all unmarried females under 25 years of age.

HLDI Publications

Research reports published by the Highway Loss Data Institute are:

R72-1 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1972 Models,* June 1973.

R73-1 *Automobile Insurance Losses, Collision Coverages; Initial Results for 1973 Models Compared with 1972 Models,* September 1973.

R73-2 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1973 Models,* March 1974.

R73-3 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1973 Models During Their First Two years,* December 1974.

R73-4 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1973 Models During Their First Three Years,* December 1975.

R74-1 *Automobile Insurance Losses, Collision Coverages; Initial Results for 1974 Models,* May 1974.

R74-2 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1974 Models During Their First Year ,* December 1974.

R74-3 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1974 Models During Their First Two Years ,* December 1975.

R75-1 *Automobile Insurance Losses, Collision Coverages, Initial Results for 1975 Models,* July 1975.

R75-2 *Automobile Insurance Losses, Collision Coverages; Variations by Make and Series, 1975 Models During Their First Year,* December 1975.

R76-1 *Automobile Insurance Losses, Collision Coverages; Initial Results for 1976 Models,* June 1976.

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